



## **Birds of the riparian corridors of Potchefstroom, South Africa**

**Rindert Wyma**

Dissertation submitted in partial fulfilment of the requirements for the degree Magister Scientiae in Environmental Sciences at the North-West University (Potchefstroom Campus)

**Supervisor: Prof. Henk Bouwman**

November 2012

Potchefstroom

## Table of Context

	<u>Pg.</u>
<i>Acknowledgements</i> .....	5
<i>Abstract</i> .....	6
<i>Opsomming</i> .....	8
<i>Key words</i> .....	10
<i>Sleutelwoorde</i> .....	10
<i>List of tables</i> .....	11
<i>List of figures and images</i> .....	13
<i>List of abbreviations</i> .....	17
<b>Chapter 1: Introduction</b> .....	<b>18</b>
1.1. Introduction.....	18
1.1.1. Riparian ecosystems.....	18
1.1.2. Urban environments and their effects on riparian ecosystems.....	20
1.1.3. Biodiversity.....	21
1.1.4. General, ecological and scientific importance of birds.....	24
1.1.5. Habitat selection.....	26
1.1.6. Community ecology.....	28
1.2. Motivation.....	30
1.3. Objectives and hypothesis.....	31
1.4. Research framework.....	32
<b>Chapter 2: Literature review</b> .....	<b>33</b>
2.1. Factors affecting avian diversity and communities in riparian ecosystems.....	33
2.1.1. Time.....	33
2.1.2. Space.....	34
2.1.3. Riparian Habitats.....	34
2.1.3.1. Riparian vegetation structure.....	35
2.1.3.2. Anthropogenic factors.....	38
2.1.4. Food and feeding.....	39
2.1.5. Nesting sites.....	41
2.1.6. Water.....	42
2.1.7. Competition.....	43
2.1.8. Predation.....	45
2.1.9. Learning.....	45
2.1.10. Presence of other species.....	45
2.2. Conclusion.....	46

<b>Chapter 3: Methods</b> .....	<b>47</b>
3.1. Study area.....	47
3.1.1. Location.....	47
3.2.1.1. Spitskop Spruit description.....	51
3.2.1.2. Wasgoed Spruit description.....	51
3.2.1.3. Mooi River description.....	52
3.2. Bird survey techniques.....	53
3.3. Environmental factors survey method.....	56
3.4. Data analyses: Transect time profiles.....	60
3.5. Data analyses: Multivariate analyses.....	61
3.5.1. One-way cluster analysis .....	62
3.5.2. NMS (Non-metric multidimensional scaling).....	62
3.5.3. Indicator species analysis.....	64
3.5.4. Multivariate analyses for the nesting and feeding guilds.....	65
<b>Chapter 4: Results</b> .....	<b>67</b>
4.1. Species-area curve.....	67
4.2. Species richness.....	67
4.3. Transects-time profiles.....	75
4.3.1. Spitskop- & Wasgoed Spruit.....	75
4.3.2. Mooi River.....	78
4.4. Multivariate analyses.....	82
4.4.1. Vegetation structure and anthropogenic factors.....	84
4.4.2. Anthropogenic factors.....	97
4.4.3. Nesting guilds and the summer CAHs.....	108
4.4.4. Feeding guilds and the summer CAHs.....	119
<b>Chapter 5: Discussions and conclusions</b> .....	<b>124</b>
5.1. Species-area curve.....	124
5.2. Species richness.....	124
5.3. Spatial and temporal changes in bird variables.....	125
5.4. Multivariate analyses.....	127
5.4.1. Characterised avian habitats (CAHs).....	127
5.4.2. Bird communities and vegetation structure.....	128
5.4.3. Bird communities and anthropogenic factors.....	131
5.4.4. Avian diversity and CAHs.....	134
5.4.5. Nesting and feeding guild communities.....	137
5.4.5.1. Nesting guild communities.....	137
5.4.5.2. Feeding guild communities.....	143
5.5. Conclusion.....	146

<b>References.....</b>	<b>150</b>
<b>Appendix.....</b>	<b>155</b>
Appendix A: River ecological profiles.....	155
Appendix B: Distribution of CAHs.....	183

## **Acknowledgements**

*I would like to dedicate this project to our Heavenly Father who has given me the talent, intelligence, and the determination to complete this study.*

I would also like to thank the following people who were involved, and have been a great help to me during this study.

- ✚ My lovely wife Lynette, who supported and motivated me throughout this study.
- ✚ Professor Henk Bouwman, for his guidance and support.
- ✚ Professor Sarel Cilliers, for his financial contribution.
- ✚ Professor Pieter Theron and Dr. Gordon O'Brien, for their guidance and support.
- ✚ School of Biological Sciences, for providing infrastructure and the use of their vehicles for fieldwork.
- ✚ Lastly, my parents, brother and two sisters who supported me during the completion of this study.



White-throated Swallow, *Hirundo albigularis* underneath a road bridge in Wasgoed Spruit

# **Birds of the riparian corridors of Potchefstroom, South Africa**

## ***Abstract***

A riparian ecosystem is the area between the aquatic and terrestrial setting of a stream, and serves as a corridor and habitat for birds. Several riparian ecosystems are located in urban environments, and three main riparian corridors are located in Potchefstroom. They are the Mooi River, Wasgoed Spruit, and Spitskop Spruit, which encompass a wide range of different vegetation types and anthropogenic factors. Therefore, different habitat types for birds occur along the riparian corridors of Potchefstroom. Factors such as food and water availability, nesting sites, competition, predation, learning, presence of other species, and those species that are able to adapt to environmental changes influence the avian diversity and communities along riparian corridors.

The hypothesis is that bird variables along the riparian corridors in Potchefstroom are affected by vegetation, anthropogenic, and seasonal influences. To investigate these affects, two secondary objectives were formulated. The first was to characterise riparian avian habitats (CAHs) according to vegetation and anthropogenic factors, and the second was to identify temporal and spatial changes in avian variables.

The three streams were divided into 79 consecutive transects, each 300 m long. The study area consisted of: 17 transects along Spitskop Spruit, 12 along Wasgoed Spruit and 50 along the Mooi River. Bird observations were conducted monthly from June 2006 to June 2007. Birds that were observed with a perpendicular distance  $\leq 30$  meters towards the streams were included in the results. The bird species that were observed were also classified into different nesting and feeding guilds.

Environmental data recorded included: vegetation structure (estimated cover percentages and height classes of trees, shrubs, grasses, herbs, sedges, and reeds), anthropogenic structures (estimated cover percentages of roads, footpaths, bridges, electrical pylons, houses, and drainage pipes), and the presence of informal settlers along each transect (the mean number of people and the space they occupy). Vegetation was monitored in summer–

(February 2007 until April 2007) and winter months (June 2007 until August 2007). The anthropogenic structures and the presence of informal settlers (anthropogenic factors) were monitored simultaneously with the bird counts.

Transect-time profiles were drawn for the four parameters, which differed on spatial and time scales. Multivariate analyses included non-metric multidimensional scaling (NMS), cluster analysis, and indicator species analysis. Cluster analyses and NMS bi-plots were used to define characterised avian habitats (CAHs). Two types of CAHs were characterised: Summer CAHs (summer vegetation and anthropogenic factors) and Anthropogenically CAHs (Anthropogenic factors alone). Bird species were then ordinated with the summer and anthropogenically CAHs on NMS successional vector graphs. The successional vectors illustrate the avian community trajectories of the different CAHs. Indicator species analyses were performed to describe associations between the bird species and the summer and anthropogenically CAHs.

The summer and anthropogenic CAHs that were characterised had different avian community trajectories and different species were associated with these CAHs. Different levels in avian diversity appeared among these CAHs, and convergence and divergence in communities appeared among these CAHs. Birds also selected their habitats according to feeding and nesting behaviours.

Consequently, it can be deduced that environmental factors such as vegetation structures and anthropogenic factors, as well as seasonality, had an effect on the distribution of birds along the riparian corridors of Potchefstroom.

# **Voëls langs die rivieroewers van Potchefstroom, Suid-Afrika (Birds of the riparian corridors of Potchefstroom, South Africa)**

## ***Opsomming***

'n Rivieroewer bestaan uit 'n akwatiese en terrestriële deel, en dien as 'n korridor en 'n habitat vir voëls. Daar is heelwat rivieroewers in stedelike omgewings, en drie word in Potchefstroom gevind, naamlik die Mooirivier, Wasgoedspruit en Spitskopspruit, en elk bestaan uit 'n verskeidenheid van plantegroeitipes en antropogeniese faktore. Dit wil sê, verskillende habitattipes vir voëls kom langs die betrokke oewers voor. Faktore soos die beskikbaarheid van voedsel en water, die geskiktheid van nesmaakplekke, kompetisie, predasie, leer, die teenwoordigheid van ander spesies, en die potensiaal van spesies om aan te pas by omgewingsveranderinge beïnvloed die voëldiversiteit en -gemeenskapsamestelling langs rivieroewers.

Die volgende hipotese is geformuleer: “Voëlveranderlikes langs die rivieroewers van Potchefstroom word geaffekteer deur verskillende plantegroeitipes, antropogeniese faktore, en seisoenswisselinge.” Om die hipotese te ondersoek, is twee sekondêre doelwitte geformuleer. Die eerste was om verskillende voëlhabitate te karakteriseer (KVHe) na aanleiding van die verskillende plantegroeitipes en die antropogeniese faktore. Die tweede doelwit was om voëlveranderlikes oor tyd en ruimte bepaal.

Nege-en-sewentig transekte is in die studie-area uitgemeet, en elke transek was ongeveer 300 meter lank. Daar was sewentien transekte langs Spitskopspruit, twaalf langs die Wasgoedspruit, en vyftig langs die Mooirivier. Voëlwaarnemings is gekwantifiseer in terme van spesierykheid en volopheid, en is maandeliks bepaal in elke transek vanaf Junie 2006 tot Julie 2007. Die voëls is ook geklassifiseer in nes- en voedselgilde, en is slegs getel as hulle binne 30 meter aan weerskante van die stroom voorgekom het.

Omgewingsdata het bestaan uit plantegroeistrukture (persentasie bedekkings en onderskeidende hoogtes van bome, struik, kruie, watergrasse, en riete) en antropogeniese faktore (persentasie bedekking van paaie, voetpaadjies, brûe, kraglyne, huise, en dreineringspype), asook die



teenwoordigheid van hawelose mense langs elke transek (die gemiddelde aantal persone en die area wat hulle benut). Plantegroei is gemoniteer tydens somer (Februarie 2007 tot April 2007) en winter (Junie 2007 tot Augustus 2007), en die antropogeniese strukture en die teenwoordigheid van hawelose mense (antropogeniese faktore) is gemoniteer tydens die voëlopnames.

Transek/tydgrafieke is getrek vir elk van die vier parameters en dit het getoon dat die vier parameters oor tyd en ruimte varieer. Meervoudige veranderlike analyses het bestaan uit nie-metriese multi-dimensionele skalering (NMS), groeperingsanalise, en indikatorspesie-analise. Groeperingsanalises en NMS-biplotgrafieke is gebruik om die verskillende voëlhabitate te karakteriseer (KVHe). Somer KVHe (somerplantegroei en antropogeniese faktore) en Antropogeniese KVHe (slegs antropogeniese faktore) is gekarakteriseer. Voëlspesies is daarna geördineer met die KVHe in NMS met opeenvolgende vektore, wat die verandering van voëlgemeenskappe oor tyd geïllustreer het. Assosiasies tussen voëlspesies en die verskillende KVHe is bepaal deur middel van indikatorspesie-analises.

Elkeen van die KVHe was geassosieer met verskillende voëlspesies, en voëlgemeenskappe het ook kenmerkend by elke KVH oor tyd verander. Voëldiversiteit het ook gevarieer tussen die KVHe, en oorvleuelende en verskillende gemeenskappe het voorgekom tussen die KVHe. Voëls het ook hul habitats geselekteer na aanleiding van voedsel- en nesvoorkeure.

Gevolgtrek kan dit afgelei word dat omgewingsfaktore soos plantegroei, antropogeniese faktore, en seisoene 'n impak op die verspreiding van voëls langs die rivieroewers van Potchefstroom uitoefen.

### ***Key words***

Birds, Riparian corridors, Potchefstroom, Vegetation structure, Anthropogenic factors, Informal Settlers, Seasonal influences, Feeding guilds, Nesting guilds, Habitat selection, Converge and diverge communities, community trajectories

### ***Sleutelwoorde***

Voëls, Rivieroewers, Potchefstroom, Plantegroei strukture, Antropogeniese faktore, Informele settelaars, Seisoenale veranderlikes, Nes- en voedsel gildes, Habitat seleksie, Oorvleulende en diverse voël gemeenskappe, verandering van voël gemeenskappe

## ***List of tables***

<b><u>Chapter 3:</u></b>	<u>Pg.</u>
<b>Table 3.1</b> Different height classes of trees (Edwards 1983). .....	58
<b>Table 3.2</b> Different height classes of shrubs, grass, herbs, sedges and reeds (Edwards 1983). .....	58
<b>Table 3.3</b> Different cover classes of trees, shrubs, grass, herbs, sedges, and reeds (Edwards 1983). .....	59
<b>Table 3.4</b> The different cover classes of the anthropogenic factors. .....	59
<b>Table 3.5</b> The different cover classes for the occupied space of the informal settlers. .....	60
<b><u>Chapter 4:</u></b>	
<b>Table 4.1</b> Presence (1) and absence (0) of species observed along Spitskop Spruit (SS), Wasgoed Spruit (WS), and the Mooi River (MR). .....	68
<b>Table 4.2</b> Species with their Roberts numbers, common English names, scientific names, feeding- and nesting guilds, and mean body mass. .....	71
<b>Table 4.3</b> The observed indicator values (IVs) of the birds in the summer CAHs. .....	91
<b>Table 4.3.1</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with G/R (Grass and Reeds). .....	94
<b>Table 4.3.2</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with HSG (Herbs, Shrubs, and Grass). .....	95
<b>Table 4.3.3</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with C/R (Concrete riverbed in residential area). .....	95
<b>Table 4.3.4</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with S/R (Shrubs and Reeds). .....	95
<b>Table 4.3.5</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with T/G (Trees and Grass). .....	95
<b>Table 4.3.6</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with TSR (Trees, Shrubs, and Reeds). .....	96

<b>Table 4.4</b> The observed indicator values (IVs) of the birds in the anthropogenic CAHs.	102
<b>Table 4.4.1</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with Dpi (Drainage pipes).	105
<b>Table 4.4.2</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with Fpa (Footpaths).	105
<b>Table 4.4.3</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with DrE (Dirt roads and electrical pylons).	105
<b>Table 4.4.4</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with InS (Informal settlers and their occupied space).	106
<b>Table 4.4.5</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with C/R (Concrete riverbed in residential area).	106
<b>Table 4.4.6</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with FpB (Footpath bridges).	106
<b>Table 4.4.7</b> Species with significant ( $P \leq 0.0030$ ) observed indicator values (IVs) associated with TrB (Roads, Road/Train bridges).	107

## ***List of figures and images***

### **Chapter 1:**

<b>Figure 1.1</b> River ecological profile of a riparian habitat adapted from Dunajewski (1938) and Lachavanne and Juge (1997). .....	20
--	----

### **Chapter 2:**

<b>Figure 2.1</b> Vegetation structures that can occur along riparian habitats (adapted from Lachavanne and Juge (1997)). .....	36
<b>Figure 2.2</b> Roles that vegetation plays within a typical riparian habitat (adapted from Karakatsoulis <i>et al.</i> (1999)). .....	38

### **Chapter 3:**

<b>Figure 3.1</b> Aerial photograph of Potchefstroom. .....	48
<b>Figure 3.2</b> Map of Potchefstroom. .....	49
<b>Figure 3.3</b> Map of Potchefstroom illustrating different sectors (indicated alphabetically) along the three streams. .....	50
<b>Figure 3.4</b> The arrangement of the 79 sequential transects along Spitskop Spruit (S1-S4 and S5-S17), Wasgoed Spruit (W1-W12), and the Mooi River (M1-M50). .....	54
<b>Figure 3.5</b> The bird counting method. .....	55
<b>Figure 3.6</b> Cross-section illustrating the five bands in each transect. CL and BL are positioned on the left side of the stream, and BR and CR are positioned on the right side of the stream when looking downstream. .....	57
<b>Figure 3.7</b> Images illustrating the environmental factors that were surveyed at each transect. .....	57

## **Chapter 4:**

**Figure 4.1** Species-area curve of the total number of species observed along the 79 transects. The dotted lines are the confidence bands, indicating plus or minus two standard deviations from the curve (McCune & Mefford 1999b).

.....67

**Figure 4.2** Transect-time profile of the RAD of Spitskop and Wasgoed Spruit from June 2006 to June 2007.

.....75

**Figure 4.3** Transect-time profile of the species richness of Spitskop and Wasgoed Spruit from June 2006 to June 2007.

.....76

**Figure 4.4** Transect-time profile of the Shannon-Wiener diversity index of Spitskop and Wasgoed Spruit from June 2006 to June 2007.

.....77

**Figure 4.5** Transect-time profile of the TAB of Spitskop and Wasgoed Spruit from June 2006 to June 2007.

.....78

**Figure 4.6** Transect-time profile of the RAD of the Mooi River from June 2006 to June 2007.

.....78

**Figure 4.7** Transect-time profile of the species richness of the Mooi River from June 2006 to June 2007.

.....79

**Figure 4.8** Transect-time profile of the Shannon-Wiener diversity index of the Mooi River from June 2006 to June 2007.

.....80

**Figure 4.9** Transect-time profile of the TAB of the Mooi River from June 2006 to June 2007.

.....81

**Figure 4.10** NMS ordination of the change in summer and winter vegetation structure of each transects found along Spitskop Spruit (S), Wasgoed Spruit (W), and the Mooi River (M). Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).

.....82

**Figure 4.11** Cluster dendrogram of all transects according to the summer vegetation structure and anthropogenic factors. The cut-off point used was at 38%.

.....85

**Figure 4.12** NMS bi-plot of all transects with the summer vegetation structure and anthropogenic factors. Three dimensions were derived, but only dimensions 1 (x-axis) and 2 (y-axis) are shown.

.....86

**Figure 4.13** NMS ordination of the species within the eight summer CAHs. Three dimensions were derived, but only dimensions 1 (x-axis) and 3 (y-axis) are shown as they showed best separation of the CAH avian community trajectories.

.....88

**Figure 4.14** NMS ordination of bird species with the six summer CAHs. Three dimensions were derived, but only dimensions 1 (x-axis) and 3 (y-axis) are shown as they showed best separation of the CAH avian community trajectories

.....90

**Figure 4.15** Cluster dendrogram of all transects according the anthropogenic factors. The cut-off point used was at 50%.

.....98

**Figure 4.16** NMS bi-plot of all transects with the anthropogenic factors. Three dimensions were derived, but only dimensions 1 (x-axis) and 2 (y-axis) are shown.

.....99

**Figure 4.17** NMS ordination of the species with the eight anthropogenic CAHs. Three dimensions were derived, but only dimensions 1 (x-axis) and 3 (y-axis) are shown as they showed best separation of the CAH avian community trajectories.

.....101

**Figure 4.18** NMS ordination of 20 tree-nesting species and the summer CAHs. Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).

.....109

**Figure 4.19** NMS ordination of 14 tree/shrub and shrub-nesting species and the summer CAHs. Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).

.....110

**Figure 4.20** NMS ordination of 11 tree/reed-nesting species and the summer CAHs. Several coordinates of the CAHS are excluded for visibility. Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).

.....111

**Figure 4.21** NMS ordination of 25 grass/reed, grass, and reed-nesting species and the summer CAHs. Several coordinates of the CAHS are excluded for visibility. Three dimensions were derived, but only dimensions 1 (x-axis) and 3 (y-axis) are shown, as they showed best separation of the CAH avian community trajectories.

.....113

**Figure 4.22** NMS ordination of 13 shrub/grass and shrub/reed-nesting species and the summer CAHs. Three dimensions were derived, but only dimensions 2 (x-axis) and 3 (y-axis) are shown, as they showed best separation of the CAH avian community trajectories.

.....114

**Figure 4.23** NMS ordination of 24 ground and ground/grass-nesting species and the summer CAHs. Three dimensions were derived, but only dimensions 2 (x-axis) and 3 (y-axis) are shown, as they showed best separation of the CAH avian community trajectories.  
.....115

**Figure 4.24** NMS ordination of 9 parasitic-nesting species and the summer CAHs. Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).  
.....116

**Figure 4.25** NMS ordination of 12 cavity and cavity/tree-nesting species and the summer CAHs. Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).  
.....117

**Figure 4.26** NMS ordination of 13 structure/tree and structure-nesting species and the summer CAHs. Several coordinates of the CAHS are excluded for visibility. Three dimensions were derived, but only dimensions 1 (x-axis) and 2 (y-axis) are shown, as they showed best separation of the CAH avian community trajectories.  
.....118

**Figure 4.27** NMS ordination of 67 insectivore species and the summer CAHs. Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).  
.....120

**Figure 4.28** NMS ordination of 27 granivore species and the summer CAHs. Three dimensions were derived, but only dimensions 1 (x-axis) and 2 (y-axis) are shown as they showed best separation of the CAH avian community trajectories.  
.....121

**Figure 4.29** NMS ordination of 35 carnivore species and the summer CAHs. Two dimensions were derived, Dimensions 1 (x-axis) and 2 (y-axis).  
.....122

**Figure 4.30** NMS ordination of 20 omnivore species and the summer CAHs. Three dimensions were derived, but only dimensions 2 (x-axis) and 3 (y-axis) are shown as they showed best separation of the CAH avian community trajectories.  
.....123



## ***List of abbreviations***

GPS – Geographical Positioning System  
RAD – Relative avian density  
TAB – Total avian biomass  
NMS – Non-metric multidimensional scaling  
CAH – Characterised avian habitats  
IV – Observed indicator value

### The different CAHs

TSR – Trees, shrubs and reeds  
T/G – Trees and grass  
S/R – Shrubs and reeds  
G/R – Grass and reeds  
HSG – Herbs, shrubs and grass

C/R – Concrete riverbed  
Dpi – Drainage pipes  
Fpa – Footpaths  
DrE – Dirt roads and electrical pylons  
InS – Informal settlers  
FpB – Footpath bridges  
TrB – Tar roads, road and train bridges  
Hou - Houses